

<b>Study program:</b> Mechanical engineering			
<b>Type and level of studies:</b> Bachelor studies			
<b>Course unit:</b> Heating systems			
<b>Teacher in charge:</b> Prof. Dr Rade Karamarković			
<b>Assistant:</b> Đorđe Novčić			
<b>Language of instruction:</b> English			
<b>ECTS:</b> 6			
<b>Prerequisites:</b> Basic knowledge of engineering thermodynamics			
<b>Semester:</b> Winter semester			
<b>Course unit objective:</b> Learning students to design central heating systems.			
<b>Learning outcomes of the course unit</b>			
Upon completion, students will be able to: calculate the physical parameters of building envelopes and heat losses; design two-pipe gravity heating systems; design two-pipe, single-pipe, and panel heating systems; balance hydronic heating systems; calculate the main elements of boiler rooms and thermal substations; explain the basics of district heating.			
<b>Course unit contents</b>			
<i>Theoretical classes</i>			
Thermal comfort. Calculation of heat losses. Types and choice of heating devices and systems. Types of heating appliances. Thermosyphon heating systems, pipe dimensioning. Forced circulators in central heating systems. Sizing and balancing of systems: two-pipe and single-pipe heating systems. Panel heating: types, characteristics, sizing of heating panels, and dimensioning of the pipe network. Calculation of main boiler room elements: hydraulic switches, expansion vessels, safety lines, safety valves, and chimneys. Balancing of hydronic central heating systems. Low-pressure steam heating: types of systems, their usage, sizing distribution, and condensate lines. District heating systems: types, main elements, and tendencies. Calculation of thermal substations: heat exchangers, regulatory and safety armature.			
<i>Practical classes</i>			
In parallel with theoretical classes, students do numerical examples. In addition, students will be trained to use software for the design of central heating systems. Visits to a district heating company. Laboratory exercises (3): determining the thermal conductivity of an outer wall, measurement of water speed in pipelines, and balancing a hydronic system.			
<b>Literature</b>			
1. B. Todorović. Design of central heating systems. Faculty of mechanical engineering in Belgrade. Belgrade 2010.			
2. R. Karamarković. ppt lectures and numerical examples.			
3. VDI Heat Atlas, 2010			
<b>Number of active teaching hours</b>			<b>Other classes</b>
Lectures: 30	Practice: 30	Other forms of classes: 5	Independent work: 10
Laboratory exercises			
<b>Teaching methods</b>			
Theoretical lectures and auditory exercises with computational examples. Field visit to a district heating company. For a given building student calculates heating requirements, analyzes energy efficiency improvement, and designs: two and one-pipe heating systems with radiators, panel heating system, and determines components in the boiler room.			
<b>Examination methods ( maximum 100 points)</b>			
<b>Exam prerequisites</b>	<b>No. of points:</b>	<b>Final exam</b>	<b>No. of points:</b>
Student's activity during lectures	10	oral examination	40
practical classes/tests		written examination	
Seminars/Homework		.....	
Project	50		
Other			

<b>Grading system</b>		
<b>Grade</b>	<b>No. of points</b>	<b>Description</b>
<b>10</b>	<b>91-100</b>	Excellent
<b>9</b>	<b>81-90</b>	Exceptionally good
<b>8</b>	<b>71-80</b>	Very good
<b>7</b>	<b>61-70</b>	Good
<b>6</b>	<b>51-60</b>	Passing
<b>5</b>	<b>Less than 51</b>	Failing